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Rosemary Bartlett: Welcome everyone, I'm Rosemary Bartlett with the Pacific Northwest National Laboratory and I'd like to welcome you to today's Energy Code Commentator Webinar, What You Need To Know About The New Energy Standard For Commercial Buildings: Standard 90.1 2019.

Our speakers today are Drake Erbe, Len Sciarra, Jeff Boldt, Michael Myer, presenting for Kelly Seger, Michael Rosenberg, and Reid Hart.

Welcome to all the speakers and welcome again, to all of you.

Drake Erbe: As chair of the standard, it is my pleasure to begin the presentation of the 2019 version of 90.1 with the chair's overview of its goals and results.

Goal 1 and primary objective is to publish a consensus minimum requirement standard that saves energy, is technically feasible, and cost effective.

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Compliance is necessary in order to deliver thy energy savings resulting in each version of the standard. Therefore, clarity leading to understanding of the standard is necessary to achieve compliance.

During the 2013 cycle it was determined that it is necessary to look further out than three years if the standard is going to remain viable moving into the future. To do that, a real understanding of the changing built environment landscape is required and the working group dedicated to that was formed to advises on areas that should be pursued.

It should be noted, in addition to publication of the standard there will be a Department of Energy determination of both energy and cost effectiveness. And it will be performed in the near future to establish this version as a standard of care.

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Under goal two, compliance, significant effort was made this cycle to look at the entire standard and to improve clarity. So build documentation was enhanced, definitions and references were

analyzed and either improved or deleted if not necessary. Additions and alterations is an area that has not been as clear as it could be and has led to some confusion in the past. This had been addressed in all sections but especially section four since its responsibility is compliance.

In order for a building to operate as designed it must be commissioned. For the first time a cross cutting workgroup was formed to take a hard look at this area and I am happy to say, were successful as you will see further in this presentation.

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On the goal of viability and strategic direction two areas were identified that will affect the standards viability so cross cutting workgroups were formed to look at widening title, purpose, and scope to include site and inclusion of renewables into the standard. Their efforts resulted in addenda out for public review and will continue, as well, into the next cycle.

As chair, I would like to thank PNNL, The Department of Energy, and all of the volunteers, commenters and ASHRAE staff for their support in the publication of ASHRAE Standard 90.1 2019.

Len Sciarra: Hi, so my name is Len Sciarra and I'm an architect and I'm a chair of the Envelope Subcommittee.

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And this part of the seminar is going to cover the envelope portions of 90.1 otherwise known as Chapter 5.

So there were a couple three types of changes that were made and they kind of been grouped in these categories of clean up type changes that were fixing mistakes, there were some criteria changes, and then there were what I call text rearrangement type changes. And I'm just showing this graph, this is a typical 90.1 building that was designed in the '70s that sort of is supposed to represent all of the buildings that we build now and the different space, condition, and categories.

So just a real quick refresher, as you know, from the other parts of the seminar and the history of 90.1 that there are different chapters. Chapter 5 is Envelope and then there's a flow chart that sort of goes through all the subsections. And then within each chapter there's the multiple compliance paths.

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Within Chapter 5 there's a prescriptive path, there's a tradeoff path that is typically know as ComCheck. There's section 11, which is a code compliant type of energy modeling tradeoff. And then, Appendix G, which is a little bit more flexible performance modeling tradeoff.

They're all acceptable to Chapter 5 and when they go over the appendixes they'll talk about the specifics. But in general, you can use all of those to comply with Chapter 5.

The important thing to note we're going to talk about later is that there was some changes with 5.7, 5.8, and 5.9 in terms of compliance that relate to commissioning. And I believe on another part of the seminar there's a discussion about commissioning and how that relates to the overall standard.

Okay, so in terms of the updates, we did some definition changes, we talked about there was a change to the Cool Roof Rating Council Standard. So if you're doing specs that important to note.

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We added some clarification for rooftop minors and that the word operable will become a little bit more nuanced when we get into the fenestration criteria.

And then we did a lot with doors in terms of clarifying what a door is versus a revolving door, versus an overhead door. So they're not stringent to the requirement but depending on if you do work for a door manufacturer, they may impact you so it is important to sort of understand. From a general architecture point of view, it's probably not that much more stringent but from a very specific door assembly some of these may come to play. And so just be aware of that depending on sort of where you're coming from.

So let's get to the meat of the changes. On the criteria changes the real big changes were in the windows. And there were two big changes that happened. They were criteria changes, the actual SHGC and U factor values and there were category changes.

So the way 90.1 is structured, if you guys remember, there's a table and then within that table there's like a sub-table for fenestration.

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And before, the fenestration was broken out into nonmetal framing and metal framing. And then within metal framing it was fixed, operable and entrance. So we combined that to make it material neutral. So now a metal window is compared to a vinyl window, which is compared to a wood window and we've broken it out into how those windows operate fix operable and then an entrance door. And remember, we talked about doors before and so entrance door comes into that as a door that's more than 25 percent glaze.

So within those fixed and operable categories now we have criteria and primarily that's because an operating type window typically has a heavier frame and so the criteria tend to be a little bit more relaxed versus a fixed window just because it has the handle, all the geometry of the operating.

So your curtain walls would fall under fixed. And punched windows if it’s a casement would fall under fixed or I'm sorry, a picture window.

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If it's a casement or double-hung whether it's metal, aluminum, or wood would all fall under operable.

So that's like the first big thing to note on in the 2019 changes.

Okay, the more significant change to the envelope was the criteria for the actual values. And within 90.1 there's an SHGC requirement, which is a sort of a heat gain, heat reduction strategy and there's a U factor requirement, which is a thermal transmission requirement.

So the material neutrality didn't really affect the SHGC that is just a factor of better glass technology being more cost effective and so across the board SHGC has gotten a little bit better except for climate zone zero. Which is the kind of the really hot, it's either depending on A or B you're either in like the Middle East or you're in Hawaii.

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So for U factor that's where the material neutrality really did come into play and the changes here, I'm showing are for metal framing fixed. So you'll notice they all have gotten a little bit more stringent. Again, for the U Factor, lower number is better, higher number is more transmissive.

And so, all of the metal frames have gotten or the metal frames have gotten more stringent. However, if you are a nonmetallic frame you may see a decrease in stringency. It's important to note what type of window you're using now; the code may be more stringent or less stringent sort of depending upon your point of view.

We're still limited to 40 percent window wall ratio within the compliance path here but that window type will drive a lot of your energy use and is a part of the tradeoff that you use for Chapter 11 even 5.6 ComCheck and appendix G.

Okay, the other criteria change is really more of an exception.

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It was related to the vestibule requirement, which primarily says all buildings should have either a revolving door or a vestibule. And then, there were exceptions for small buildings, warm climates, semi-heated buildings.

We've added an air curtain allowance that allows you to install an air curtain to a self-closing door. And there's two categories, there's warmer climates and there's colder climates. The warmer climates in one and two are no, it's not a typo it is really 0, 3, and 4. That building size is not limited in the colder climates, 5-8, 15-stories or less to avoid the stack effects. Where the air currents don't really work, they can't overcome that stack effect.

And basically, you can install an air curtain on these automatic doors you have to as you're writing your spec requirements make sure, there's ANSI requirements, jet velocity angles. And they have to be commissioned and there's control requirements that are in Chapter 10.

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So just to make sure when you're installing these things that they do relate to your other disciplines, it's not just a matter of buying an air curtain and sticking it on a door.

The last section was text rearrangements and there's two things that happened here, one was on air leak and one was on inspections. So before, air leakage was very simply a material requirement or an assembly requirement or a building testing requirement. And you sort of went in that order because that's the way we as architects were thinking about pieces.

Small pieces had a very tight test requirement, a piece of drywall, an air barrier, you would join that piece with other pieces to make assemblies, and we know that there are some joints and some leaks so they got more relaxed. And then when you join those assemblies into buildings, you get more leaks. And so, we sort of came up with a .004, .04, .4 and then there's an exception that brings you back to .6.

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So that's all still in there it's just rearranged a little bit to align a little bit more with the commission requirements and the idea that a whole building air test really is the gold standard for high performance building.

So the charging paragraph now is the .04 with the exception for the .6. And the exception is the material and assembly compliance.

So when you're reading this, it's encouraging to do the whole building or portions of buildings but you always have the exception to do the inspections and testing and compliance, which then goes references 5.7, 5.8, and 5.9 where all the product requirements are, the material requirements for air leakage. All the stuff that used to be in the air leakage section is now in the product section where it appropriately belongs because it's a product specific requirement.

And then, 5.9 we'll talk about in a second that's the inspection piece.

So 5.9 got rewritten to align with the commissioning pieces as well. It used to be just two sections, verification, and

inspections and now it's verification, testing, commissioning, and inspections.

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And you'll see this similar parallel structure in all the sections of 5.9.1., 5.9.2, 5.9.3. They deal with verification, commissioning, and inspections.

Now the envelope does not have any what we would call Envelope Commissioning Requirements. Like if you, if anyone has worked on a sort of high-performance building, you'll note that sometimes there's an envelope commissioning specification section or there's an envelope commissioning agent.

This, 90.1 merely requires verification and inspections. We have the commissioning piece in there, sort of as a sort of placeholder but the requirements are really in the verification and inspection. Which means we do want you to inspect your building both for air leakage and for installation placement that all aligns with traditional building code inspections.

So that's kind of it for 90.1 envelope and onto to mechanical. Thanks.

[0:14:00]

Jeff Boldt: Thank you. I'll be giving a brief overview of the mechanical changes in 90.1 2019.

I'd like to start with a big shout out to the 90.1 committee and especially the 90.1 mechanical subcommittee, many of whom you see pictured here starting dinner and continuing to discuss how to save energy in buildings. Several vendors provided images in this PowerPoint and are acknowledged on this slide.

One of the major revisions in ASHRAE 90.1 2019 is wording that allows ANSI/ASHRAE Standard 90.4 Energy Standard for Data Centers to be used in lieu of Standard 90.1 for significant data centers.

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The wording took years to finalize but essentially, puts large data centers under the purview of 90.4 and small computer rooms inside of buildings under the purview of 90.1.

This involved creating a definition for a computer room. Fundamentally, 90.4 has more electrical efficiency requirements such as power supply efficiency minimums while 90.1 has more HVAC efficiency requirements for buildings. It was important for us to avoid definitions that would allow a small computer room in a large building to cause that building to fall under 90.4 and thus, bypass many HVAC requirements in 90.1.

The definition of a computer room is a space having greater than 20 watts per square foot of computer or IT equipment load and a total equipment load of over 10kW.

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Fan Energy Index (FEI) replaced Fan Energy Grade (FEG) in 90.1 2019. In my opinion, FEI is a much better metric for saving fan energy. FEG mainly required good fan peak efficiency. FEI, by contrast, is all about the actual selection having good wire to air efficiency.

Basically, the kW input must be below a calculated value at the scheduled operating point. High FEI numbers indicate better efficiency for the actual selection, which is somewhat different than DOEs pump energy index, which we'll talk about later.

To achieve this, the fan still must be reasonable efficient.

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The images on the right demonstrate how a fan with high efficiency, the upper image, can have a much wider bubble of acceptable efficiencies than a less efficient fan int eh lower image, which has a smaller bubble of places where you can apply that fan.

The result of the FEI requirement is that some fans must be selected with larger wheel diameters than might sometimes be done in order to the cheapest fan you can buy for that application.

I believe this is good because I see far more undersized fans scheduled than I see fans that are not efficient at any point on their curves. This probably has the biggest economic impact on returned fans in packaged air handling units because the casing sizes can be forced to become larger.

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And you may have to pick a larger diameter return fan and thus cause the casing to increase in size.

So data from a full year of production by one manufacturer showed selections made as low as nine percent static efficiency. I personally only seen them down to 19 percent but apparently, people do really undersize fans in some instances.

So in my opinion, FEI will save significant energy in HVAC systems. There are exceptions to the FEI requirement for embedded fans where the energy of the fan is already included in the product's total energy efficiency rating and we see this in rooftop units. And for safety fans, for example, vehicle tunnel smoke exhaust systems.

The threshold for the FEI requirement was also lowered from 5 horsepower to 1 horsepower.

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And more types of fans, for example, powered roof ventilators are now covered. So I believe there are significant energy savings in the inclusion of FEI.

FEI is a true wire to air energy measurement index. FEI is the ratio of a calculated reference input power to the actual fan input power for the section. The basic requirements are that either for constant speed systems the FEI must be at least 1.0, higher numbers are better or for variable speed systems, FEI must be at least 0.95.

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Many equipment tables were updated. Dick Lord did amazing work to try to cover all of these. Many of these were in response to DOE updates so that 90.1 lists the same

numbers as DOE does in the federal regulations. One of these updates was the Pump Efficiency Index, which is an appliance efficiency standard that prohibits the sale of pumps below a minimum peak efficiency level in the USA. We will come back to that in a later slide.

Ceiling fans have new requirements in 90.1 2019. Basically, ceiling fans with blade tip diameters of at least 84.5 inches must be rated per DOE 10 CFR 430 Appendix U or AMCA Standard 230.

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The fan literature must report the blade tip diameter and the rated airflow and power at maximum speed. This does not require a maximum efficiency, simply clear reporting of the actual fan efficiency. It does require a standardized rating system to help make manufacturers claims comparable. Smaller celling fans are covered in the Energy Star program.

Energy recover ventilators are now required in nontransient dwelling units. This primarily affects apartment and condominium complexes that are at least four-stories tall. The requirement is for enthalpy recovery of at least 50 percent at designed cooling condition and at least 60 percent at the designed heating condition.

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In some climate zones both heating and cooling may not be required so only one of the two requirements would apply. There are exceptions based on the climate zone and system size.

There are updates in 90.1 2019 to the exceptions to exhaust air energy recovery. A definition of series energy recovery replaced the former use of the term energy recovery in series with the coil in the text of 90.1. A performance requirement for series energy recovery was added. This requirement is limited to climate zone 0-4 so your humid climates or your hot climates. Parts of this addendum were not included in the first printing of 90.1 2019 and will be corrected through the addendum process.

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Occupied Standby is defined as when a zone is scheduled to be occupied and an occupant sensor indicates that no occupants are within the zone. This requirement is closely linked to the lighting controls in section 9.4.1.1.

Standard 62.1 2016 was amended to allow zero ventilation in unoccupied zones that are scheduled to be occupied. An example is if your office area schedule is occupied but you are not in the office today, not providing ventilation there is not permitted under 62.1 and required under 90.1.

When zones are unoccupied, air flow is permitted to those zones only when the zone temperature varies outside of the temperature limits.

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I believe this will be a significant energy savings because unoccupied spaces in buildings no longer require a minimum ventilation CFM and typically, the required reheat that goes with that.

Standard 90.1 now has a requirement for energy recovery chillers for some hospitals. The minimum capacity is at least seven percent of the designed cooling capacity. This does not include backup chillers in for the designed capacity.

I have typically seen paybacks of around four years for properly sized energy recovery systems of this type for hospitals. Tim Peglo did much of the analysis to show the economics and he employs energy recover chillers in his facilities and has seen good paybacks also.

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This requirement is limited to acute inpatient hospitals, those with 24-hour operation, those that have a chilled water capacity at designed conditions of over 300 tons, and that have simultaneous heating and cooling when the outside air temperature is about 60 degrees Fahrenheit.

There are some exceptions including when at least 60 percent of the reheat energy comes from onsite renewables or site recovered energy, climate zones 5C, 5B, 7 and 8

where the economics didn't play out to be favorable. Several types of chillers today can be used in this service including screw chillers, screw or you may call them rotary helical chillers and centrifugal multistage chillers.

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I mentioned earlier that many of the Equipment Efficiency Tables were updated to comply with the latest DOE standards. Dick Lord and Steve Rosenstock did the lion's share of these updates and I thank them heartily for doing all that hard work.

Okay, I'm going to go through some miscellaneous changes to 90.1 2019. We removed 10 unused definitions, yes, we actually made 90.1 smaller. The test additions for pool dehumidifiers were updated to AHRI standard 910 for moisture removal efficiency, which it takes out humidity or moisture as opposed to the sensible cooling efficiency.

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Air barrier and envelope leakage testing requirements were updated. This is really not a mechanical item; Len will discuss it more in detail in the envelope section but I want to point out to the HVAC engineers in our audience that this is very important for your load calculations.

When you make load calculations or at least when I do, there are two major guesses, I don’t know what to call them other than guesses that every engineer or designer must make. How much infiltration should I include in the loads and what should I estimate for internal heat gains?

On the internal heat gains topic ASHRI Report 1742 reported a range of .3 to 1.53 watts per square foot. So that's a little bit thumb in the air when you make that estimate and you have to think about it quite a bit.

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I watch al the ASHRI winter and annual meeting seminars and if you have access to them, the winter seminar from 2019, seminar 52.1 covers interior heat gains from equipment quite well.

So back to the issue of infiltration. I live in Wisconsin and for zone heating loads the infiltration guestimate that I make often doubles the zone heating capacity. Not the block heating capacity, I typically divide that by two figuring the wind only blows in one direction at a time. But the more that the building codes can control infiltration, the lower the size and cost of heating systems will become and you, as an engineer, can have some confidence that the building was only supposed to leak so much.

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The limits that we passed in 90.1 2019 are not super strict but I believe that as more buildings are tested that those requirements may become more strict and maybe help lower our loads even further.

Also, a lot of wording was clarified throughout 90.1 2019. I think format and compliance did a lot of work on that and you'll hear about that in a later presentation.

Some additional miscellaneous changes to 90.1 2019, a requirement was added for indoor pool dehumidifier energy recovery and the efficiency of that energy recovery. Basically, energy recovery equipment efficiency must be at least 50 percent air sensible recovery.

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Or there must either be condenser pool heating or 50 percent exhaust air enthalpy recovery.

Another change is that air currents are now acceptable in lieu of vestibules in some situations. Len will speak to this in more detail in the envelope presentation. This isn't really a mechanical item but for the HVAC engineer this means that you may want to revise your assumptions about infiltration into lobbies.

Since you probably will be asked to specify the air curtains this also means that you should update your master specifications or schedules to include the performance requirements of 90.1 2019 for air curtains that are used in lieu of vestibules.

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The research that we reviewed showed that poorly adjusted or poorly selected air curtains can be ineffective or are perhaps even counterproductive. So it is important that you update your specifications appropriately.

I'm very interested to see how this affects lobby heating loads in the cold climate in which I live. The research presented to the 90.1 committee seems to me to be quite solid and I'm looking forward to seeing results from buildings that we design.

A third change is that electric motor selections were simplified and made to accommodate electronically commutated motors and other motors that are not rated in brake horsepower as our previous language referenced.

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One final miscellaneous item is that Standard 90.1 is starting to incorporate some of the recommendations of Guideline 36, high performance sequences of operation for HVAC systems, especially in the reheat and supplier temperature reset sequences.

Steve Tylor who is also a 90.1 mechanical subcommittee member and full committee member is leading the Guideline 36 committee and I'm sure he would be very interested in any suggestions you have for those standardized high-performance control sequences.

This is my last slide. I'd just like to let you know that the 90.1 committee is always open to ideas that will save energy economically. If you have ideas, please contact me or any member of the 90.1 committee.

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Or you could stop in an attend a meeting in Orlando or maybe attend one of the monthly web meetings. All of our meetings are announced in the ASHRI list serve. Who knows, maybe you could become a future member of Standard 90.1.

Thank you for your attention.

Michael Myer: I'm Michael Myer with Pacific Northwest National Laboratory. I'm a member of the lighting subcommittee and I will be discussing the lighting updates in ANSI, ASHRI, IES Standard 90.1 2019.

Just a quick overview about the standard specifically the lighting section, scope, and application. It applies to lighting that is powered by a buildings electrical service and can include lighting in the buildings, mounted to the exterior buildings as well as on building sites such as the parking lot, plazas adjacent to the building, and so on.

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Nonresidential buildings great than three stories, it includes multifamily residential buildings as well.

It applies to new construction, major renovation, tenant fit outs to existing buildings, addition to buildings and retrofits of an existing lighting system. A retrofit is when any more than 20 percent of the connected load is modified.

It prescribes limits in installed power, which is represented in watts per square foot, also known as a lighting power density.

It mandates functional requirements for lighting controls. Also, it has requirements that vary by application, for instance, offices and retail sales area have different lighting control requirements than maybe say a warehouse.

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There are mandatory provisions. There are prescribed limits for lighting power and those are defined by both the building area method and/or the space by space method, those are two compliance options.

There are lighting control requirements. They might be local control, dimming control, daylight control, power reduction or parking lot lighting, luminal lighting control. Those are in the two main mandatory provisions through the building area method of the space by space method.

We introduced a simplified method for lighting, which will be discussed later, which kind of tries to touch on both of those in an easier way.

There is also a section 8 which has electric power requirements, which includes automatic reciprocal control and deals with voltage. It also has to deal with metering and monitoring and reporting.

This is an agenda for what I will present today. I will first touch on the updated lighting model, we'll discuss the updated lighting power density allowances, the new simplified lighting method.

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And then really move into the other updates in the wattages, the parking garage, some daylighting as well as some nontypical exterior spaces.

Over on the right you will see the sections of ASRI Standard 90.1 2019 where these applicable changes and updates can be found.

So the first major thing to know is that the 90.1 lighting methodology, the model, was evaluated and was reconstructed. It is now representative of more real-world conditions. We went through IES recommendations. IES is the Illuminating Engineering Society and they're a cosignatory and developer of the standard.

We went through every document we could find and whenever there was a change or an update, we made that and reflected that in our model for each of the applicable space types.

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We also analyzed and reanalyzed room geometry, which is expressed in a room cavity ratio and corrected where it needed to be corrected. Also, we reviewed light loss factors and efficacy values.

In terms of efficacy this is the efficiency of the light fixture, we reviewed many, many manufacturers as well as multiple products within even a manufacturer line and updated all of

our datapoints to reflect current trends and datapoints on efficacy. We also referenced commercial programs and installed typical values to get a sense of where they were going.

We also added an additional surface reflectance category to reflect more changes and be consistent with other program. The new model now uses 100 percent LED baseline, roughly 20-30 percent of installed and projects out there are LED now, and we see this as a general trend for all new construction and renovations and it's represented by a decline in shipments of all conventional technology.

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Changes in the model then followed into the interior lighting power allowance. In general, when you see these slides, there is a gray bar at the bottom of each of the slides where the addendum to the standard can be found. So in this case Addendum BB made the modifications to the space by space power density allowances.

It was an average LPD reduction of about five percent. There are roughly 140 different spaces within the space by space list and if you just took an average of all the changes that's where you come up with five percent. If you weight that by a common or most area that number might be different.

The table over on the right just as a sample of what you'll see.

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In the first column you'll see 90.1 2016 and on the column on the right you'll see 90.1 2019 values. You can see that for many of the spaces the values decreased. In some cases, the values decreased a lot. For instance, a hotel lobby went from 1.06 watt per square foot to .51 watt per square foot. The single largest reason for that change is that the 2016 model assumed a fair amount of halogen and incandescent in there whereas the 2019 changed that to an LED because good color quality LED sources are available and offset where we had previously used halogen sources.

You'll see that some spaces had very little change, for instance, warehouse bulky, medium objects only went from .35 to .33. You can also see that in a few places' values went up, parking area interior, this is your parking garage. It went from .14 to .15.

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This is reflected because of a change related to the reluctance values.

The space by space values all flow into what is known as the building area method. So, if you are not interested in breaking down your entire building in different space you have a single value for a given building type.

Again, because the space by space values were roughly a five percent average, the building area is also rightly a five percent reduction. This was modified in Addendum CG.

Again, you can see the columns on the left are 2016 values, the columns on the right are the 2019 values. Some spaces did have some small changes, some spaces had some very large changes. Again, retail is an example as well as hotel and motel that was primarily because of technology changes from halogen to LED technology.

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Probably the largest change to the standard is this new compliance method, which is for simple buildings. Previously, I discussed the space by space method as well as the building area method those are two compliance methods, this is now a third one it is only for office, school, and retail buildings up to 25,000 square feet.

You may be thinking 24,000 square feet is not a lot of area, it turns out a number of the buildings, like 30 to 40 percent of buildings out there are less than 25,000 square feet. So it actually it covers a lot of buildings.

It is a single interior and exterior LPA power as a new target that covers the entire building. And the power allowances are lower than other methods. It is a simplified method so therefore, in exchange of making it simple you are giving up a little power.

It does require occupancy of lighting control in most spaces with some exception.

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And all power from all lights must be counted towards the interior lighting power allowance. No exemptions. This was modified as a result of Addendum BG. We'll see this now in action.

So this is a screenshot from the standard. You'll see that this is for school buildings. Notice that you have all school places, classrooms, offices, conference rooms, gymnasiums, restrooms, these all have the same single value of .7. And had you looked at schools in either the whole building or the space by space you would have seen that these spaces had different values but again, the simplified method is a single power density value for all these spaces similar to the building area method but you are getting a reduced value, again, because as an offset to make it easier to comply with. That is your exchange.

You'll see that there are some occupancy sensor requirements. There is no data _____ requirements because again, the idea is the simplified method.

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Similarly, exterior has the same kind of concept. You get a slightly lower exterior lighting power allowance and the other values for the different spaces are slightly lower than you would normally get. And again, some slightly different control requirements.

Now the concept of this is a simplified method and for somewhat easier generic buildings, office retail and schools as well as meant to be simplified making it faster for compliance reasons.

Moving on, a major update had to do with interior and exterior lighting wattage. We made some technical changes such as replace the term luminaire with lighting equipment as well as the term ballast and ballast driver to ballast driver. These were changes really to reflect changes in the lighting industry not everything is a luminaire anymore, as

well as drivers for LEDs are much more common than ballast.

We also split this section into five categories, one being line voltage for lighting equipment, another being line voltage for equipment with a remote ballast or driver, track and plug busway, as well as low voltage track.

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And finally, a new one for direct current low voltage lighting systems with flexible cabling for plug in connection of lighting equipment in a remote power supply. An example of this but not as limited to it is power over ethernet lighting.

The wattage of a DC low voltage system that employs flexible cabling for the plug-n connection of the equipment in a remote power supply shall be the maximum wattage of the power supply. So that's basically whatever that network switch is if you're using POE that's your limit.

However, if that switch, as noted in the final bullet, is providing power to other devices, so imagine you have, again, a network switch and three of the ports are powering a light fixture and two of the ports are powering other devices, you subtract the nonlighting equipment from the connected system. This was modified in Addendum AH.

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Addendum CV has to do with parking garage lighting control requirements. One of the things it did is it increased the stringency of setback in parking garages both in the percent reduction of the lighting as well as the time out period.

Over on the right you'll see a comparison. In the first column is 90.1 2016, the second column on the right is 90.1 2019.

The timeout period, so after no movement is detected, in 2016, 20 minutes had to pass before the lighting control enacted a command. Now it's 10 minutes. Similarly, in 2016 it was a 30 percent reduction was required a

minimum, now it's a minimum of 50 percent reduction requirement.
This primarily resulted because LEDs are more common especially in parking garage applications and they are available in both those ranges whereas previous technologies had more limitations.

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We update control requirements for transition lighting. Transition lighting is the lighting in an area as car are leaving the parking garage into the main flow of traffic and it has some different lighting requirements.

We also updated continuous daylight dimming to down to 50 percent required for luminaires within 20 feet of the wall opening.

We also did add this new exemption for permanent architecture screens or architectural onus. The image on the right shows kind of a concept of what that is. We're seeing now parking garages and parking facilities with exterior screens to make them look more pleasing. And as a result, it's reducing some of the light coming into the space.

So if the artificial element obstructs more than 50 percent of the opening then there are some exemptions.

Addendum AQ has to do with special applications and lighting controls. There really were no changes in terms of requirements in this section.

[0:47:00]

What it did is it reorganized it to make it easier to understand and follow. So it clarified it. It put it at tabular form here where you have the number over on the left, description, whether or not it has to be controlled separately from the general lighting system as listed. And then, any additional required controls.

So for instance, lighting specifically designed for use during medical or dental procedures you'll see that yes, in addition to and controlled separately from general lighting that's a requirement. Then you'll also see it also requires local controls.

And it also points where to the applicable texts you can find those either and that's indicated by the letter in the parenthetical after the section. That was done in Addendum AQ.

We also made some daylight and control requirements via Addendum CW. The biggest one would be continuous daylight dimming required for all spaces.

[0:48:00]

Previously it was a step dimming requirement and that was eliminated. Step dimming was very common when you had multilevel fluorescent systems and it ____ with HID. But again, network that LED is becoming more common, continuous daylight dimming just made more sense as an option.

The low point output setting is to reduce the electric lighting in power in response to available daylight via continuous dimming to 20 percent or less.

And then over there on the right, you can see what the definition of continuous dimming that it is continuous range from full output to a minimum setpoint, 20 percent. And in imperceptible steps without flickering.

We also added some text in there about how daylight dimming had worked with other controls and that's indicated in the bottom bullet.

Thank you.

Addendum CH also modified the daylighting zones. The first thing it did was it added a definition for daylight area under skylights in multistory space.

[0:49:00]

The easiest thing to think about in this is that it's a skylight in an atrium so that's typically where you might see a multistory space. The definition there on the right describes what it means that the daylight area under the skylights in multistory spaces shall include the floors directly beneath the skylight and portions of the upper most floor adjacent to the multistory space that meets the criteria for daylight

under skylights, where CH is the ceiling height of the uppermost floor.

So that provides the information of how it's defined. We also added two figures for clarity, sometimes words aren't as good as a diagram and that's why we added two figures. Also, we added some exemptions related to primary side lighted areas.

[0:50:00]

Addendum CY also made some daylight for side lighting requirements to clarify the setback distance. These are horizontal measurements previously described distance but it didn't actually articulate that it was a horizontal from the *[unintelligible]*.

We also discussed added requirements in text that added natural objects as obstructions in addition to existing structures. You might have a hill or tree or some other natural object that might be causing some daylight issues and that was included.

Finally, we removed an error that inadvertently set an exact measurement of an obstruction. The text originally said it had to be a distance of twice as high. Now the problem was is that what happens if it was just slightly more than twice or just slightly less than twice, it didn't comply. And so, by removing the requirement that it had to be exactly twice as high it made more sense for logic and more applicable. And that was made in Addendum CY.

[0:51:00]

Finally, we made changes for selecting lighting power densities for nontypical exterior areas. What this means is that there's a Table 9.4.2-2 that is a list of spaces. This might be parking areas, it might be plazas, it might be ATMs. There are some that are tradable, there are some that are non-tradable.

From time to time there are spaces that end users didn't feel that fell in this table and there was questions about which one should they use? So as a result, the concept is if there's an applicable interior space that is actually an exterior application you would go look at Table 961 and find its

power density value. And then you would appropriately reduce it based on how you find it in the table.

[0:52:00]

So an example of this might be outdoor seating in a sporting environment, if it's an open air walkway in a multistory outdoor retail plaza where the walkway is exterior that might be technically a mall concourse so you might actually go look at the interior table, find the mall concourse value.

And then what you do is you say okay, I'm now using this in an exterior application and then you find your lighting zone. So in this case, lighting zone zero, which is an intrinsically dark space you don't get any allowance. But if this mall concourse happened to be in let's say lighting zones two or three, if it was in lighting zone two you would only get 65 percent of the interior value.

Again, the concept here is that this is an exterior application so less light is needed but there might be situations where the application or the space is not in the current table of 9.4.2.

[0:53:00]

So you go, again, look at the interior space, find the applicable thing, and then derate it by the applicable value in the table. This is all listed, it was all provided, and this was all done in Addendum T.

And those were the major lighting changes in Standard 90.1 2019.

Michael Rosenberg: Welcome. Today I'm going to talk about the changes to the Whole Building Performance Paths in Standard 90.1 2019.

But first, a little background. Standard 90.1 includes Two Whole Building Performance Path options. Both use energy simulation to compare the energy cost of a proposed building design to the energy cost of a baseline building design.

The first one, the energy cost budget, section 11 uses baseline system and components that are the same as the

proposed building except their efficiency levels are back down to the current prescriptive requirements.

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We call that a dependent baseline.

The second performance path, the performance rating method, or Appendix G in that approach the baseline systems and components are independent. Instead of being based on the baseline, excuse me, on the proposed building design they are based on the architectural program of the building and the location of the building.

For example, the heating and cooling system is not based on the proposed heating and cooling system but instead is independent based on the type of building and the location.

In addition, the baseline is set at the efficiency values and the efficiency levels they're approximately equal to standard 90.1 2004. So therefore, for compliance with the standard using the performance rating method instead of just meeting he baseline you need to beat it by a certain amount. We call that a stable baseline.

The 2019 version of the standard included 23 addenda impacting ECB or Appendix G.

[0:55:00]

Those impacting ECB fell into several categories. The first were changes to align with Appendix G where appropriate. So things that had been improved in Appendix G that were improved in previous additions of the standard and ECB were not improved to catch up with Appendix G.

There are some clarifications added and then there were some updates to the baseline for consistency with the prescriptive requirements. So as the prescriptive requirements got more stringent the baseline needed to be updated as well.

In Appendix G there were some cleanups of oversights and inconsistencies. There was a tightening of the definition of the baseline so that it was less ambiguous. And that led to support for consistent modeling and automation. So

software that automates the baseline can do so with some rules that are more explicit.

Addendum G provides some rules for the efficiency of HVAC systems when you combine thermal zones into larger thermal blocks.

[0:56:00]

So Appendix G allows you to combine thermal zones for simplification into a thermal block if those thermal zones are similar enough. So that way you end up with a zone that is larger than the actual zones in your building, that can be problematic because HVAC equipment the efficiency of HVAC equipment is dependent on the size of that equipment. And in general, larger capacity equipment is not as efficient as smaller equipment.

So if you were to use the larger thermal block equipment efficiencies it would make your baseline less stringent. So this addendum just clarifies that if you do combine thermal zones into a thermal block you need to base the equipment size on the size of the equipment in the individual thermal zones not in the combine thermal block.

Addendum AL also deals with thermal zones and thermal blocks. It prescribes some requirements for when you can combine those thermal zones into a thermal block. And it tells you that you can only do that if the peak internal loads are similar.

[0:57:00]

And it gives a definition for that by telling you that they need to be within 10 BTUs per hour per square foot from the average of all the other zones in the thermal block before you can combine them.

It also makes some changes where it replaces the word spaces with HVAC zones, which is really more accurate description. This applies mostly to requirements for fan system operation.

And then, finally, it tells you that you need to use the lighting space by space method of establishing lighting power density instead of lighting building areas method, which is a broader method less granular than the space by space method.

There is an exception if you don't know the space type because it could be future buildout, something like a core and shell building where the tenant buildout hasn't been done yet. In that case you can use the building areas method.

Addendum D also deals with future building components. So if you've got not yet designed areas of your building, you're required to model it with the equipment meeting the prescriptive requirements of the current code. That way you're neither penalized or rewarded for those future building promise.

[0:58:00]

Addendum E deals with service water heating systems. Frist it tells you that you should not model piping losses. Pipe installation is required, it's a mandatory requirement in 90.1 and you don't need to model them in your simulation.

And second, it tells you that if you've got a combined service water heating and space heating system the baseline should use to separate systems not a combined system.

Addendum L corrects and oversight where the fan power for systems 12 and 13 was not prescribed for the baseline in Appendix G. Systems 12 and 13 are single zone constant volume systems used for assembly spaces. We just left that out of the last version of the standard so that was added.

Addendum M deals with modeling infiltration. It specifies that if you don't do whole building air leakage testing that if you just meet the prescriptive requirements for air leakage and air barrier –

[0:59:00]

you need to assume in hour proposed building that the air leakage, the infiltration is at 0.6 CFM per square feet exterior building area. And that is at a pressure differential of 50 pascals. It's just assumed that you meet that if you meet the prescriptive requirements. And then assess the baseline infiltration rate at one CFM per square foot.

Addendum R specifies that when your baseline building is required to use economizers those economizers need to be modeled as integrated economizers. Economizers provide

free cooling when the outside air temperature is cool enough to do that. And integrated economizers means that the outside air can work in conjunction with mechanical cooling. So let's say it's a moderate temperature, maybe 60 degrees and you can get some benefit from that cooler outside temperature but it's not cold enough to provide all the cooling. The HVAC system has to work in conjunction with the economizer, it has to be integrated with the economizer to provide that cooling.

[1:00:00]

Addendum Y has some rules for how you size your baseline HVAC equipment. It clarifies that the oversizing that Appendix G specifies only applies to the heating and cooling coil capacities not the airflow. I think Appendix G asks you to oversize your cooling coil by 15 percent and your heating coil by 25 percent but you do not do that with the airflow as well.

The second thing is it specifies that central plant capacities are based on coincident loads. That means the highest load happening at the same time not adding up the highest loads that can occur at different times. It also specifies the design day conditions for your heating and cooling sizing. It uses 99.6 percent dry bold for heating and one percent dry bold and wet bold for cooling design temperatures.

It also specifies the internal gains to be used in the sizing runs.

[1:01:00]

It tells you for your heating sizing that you set all your internal gains to the lowest hourly value that you use in the simulation. And for cooling you set it the highest annual value that you used in the simulation. That's a conservative approach. It does give an exception for residential occupancies and instead of using the highest cooling value, the highest internal gain for cooling you use the most frequent internal gain for cooling.

And that's specified in the ASHRI handbook of fundamentals and that's why that is done.

Addendum S deals with renewable energy tradeoffs and it limits the amount of tradeoff you can have against energy efficiency for renewable energy. But only when it's used for compliance with the standard. If you're going beyond the minimum requirements of the standard you can get as much credit for renewable energy as you put in your building but if you're using it trading off against efficiency for minimum compliance you're only allowed to get five percent of the baseline building energy cost as credit from that renewable energy system.

And there's some formulas here, I'm not going to go through the details of the formula but there's a formula that adjusts your performance cost index.

[1:02:00]

Based on the amount of renewable energy that you have in the building to make sure that you are still lower than the performance cost index target, which is how compliance is shown in Appendix G.

Addendum AG established the methodology for getting credit for automatic receptacle controls. 90.1 has some requirements for receptacles to be controlled based on occupancy. But if you go beyond the minimum requirements and you install those controls where they're not needed, prior to this addendum there was no way to get credit for that in Appendix B but now you can with this change.

Addendum AK was really a simplification. There was some solar heat gain coefficient and visible transmittance requirements for fenestration that were not specified directly in Appendix G. Instead it pointed you to some calculations in another part of Standard 90.1 and now that's simplified by just including tables that have the required visible transmittance and SHGC for your baseline fenestration.

[1:03:00]

Two Addenda BT and CI update the building performance factors in Standard 90.1. The building performance factors are used to establish compliance with the standard. They

adjust the performance cost index target of your building based on the building type can climate zone.

And those building performance factors basically represent the ratio of the energy cost of a building compliant with Standard 90.1 to the energy cost of a building compliant with the stable baseline, the Standard 90.1 2004 baseline. So obviously, as the standard gets more stringent with each year those building performance factors get updated as the baseline stringency stays the same. So that's a table that needs to be updated with every new version of the standard.

Addendum AZ provides some rules for commercial refrigeration system modeling.

[1:04:00]

It basically tells you that if you have a proposed building refrigeration system that's rated in accordance with the HRI standard 1200 the energy you should be modeled in accordance with that rating standard. Pretty basic.

Addendum BA deals with getting credit when the values of the baseline system are not specifically prescribed in Appendix G. There were some cases where you were told you're allowed to get credit if you go beyond standard practice but it doesn't really tell you what standard practice is.

Some examples are service water heating loads, cooking equipment, laboratory equipment. And it basically gives you, the rules it tells you are that if the baseline values are not prescribed you first look in the prescriptive requirements of sections 5-10 and if there are prescriptive requirements you use those in the baseline.

And if there aren't, you look at other codes of standards that are applicable to the building such as the plumbing code, the ventilation code, or the occupational health and safety code.

Addendum AR and BU make some minor table and language cleanup changes.

[1:05:00]

It adds the words performance rating method to the titles of some of the tables that are in Appendix G just so that it's not confusing to users. There was some redundant footnotes that were left in some tables that are removed. There were some leftover baseline references to proposed building heating source that were really not applicable since the baseline is independent from the proposed heating source. There were some places that changed the word spaces to zones in several instances, which is really more accurate.

The term process loads was changed to internal gains so that when we're looking at sizing equipment, we don't just look at the gains from process loads we look at all internal gains including lighting and the gains from people in a space.

And then, it fixed some section headings that had the wrong system numbers as more systems were added to Appendix G the numbering changed and some of those tables did not catch that in previous editions.

[1:06:00]

Addendum AT deals with recharging and refueling vehicles. It basically tells you that if you're using energy to recharge and refuel a vehicle that's used offsite you don't calculate that in the proposed or you don't include that in the proposed building energy cost.

So for example, if you've got an electric vehicle charging station that workers are using to charge their cars that they're commuting back and forth from work you don't count that in your calculations. But if it's an onsite vehicle, let's say a forklift in a warehouse that's being charged you would count it.

Addendum BK deals with onsite electricity generation systems. Things like generators, combined heat and power or fuel cells. It tells you that if you have that in your proposed building that kind of generating in your proposed building the baseline has the same generation. Except the baseline does not include any recovered heat from that system.

So if you're recovering heat from a CHP system, for example, you get credit for that by having it in your proposed design but not in your baseline.

[1:07:00]

Addendum, CJ makes various changes to the lighting requirements in ECB in Appendix G. First, in ECB it tells you that if you've got dwelling units, guestrooms or other spaces that will use plug-in lighting and the lightings not showing on the plans, the baseline lighting power has to equal the proposed lighting power. So that means you're not credited or penalized for that.

It sets the baseline lighting power for dwelling units at .6 watts per square feet. It also tells you that if you've got an existing lighting system like in an alteration or you've got a space that doesn't have a lighting design like a future tenant buildout, your baseline lighting power equals your proposed lighting power. Once again, you're not penalized or rewarded in that instance.

And then, it also tells you that when you're doing for your daylighting calculations you need to treat primary, secondary, and top lit daylight areas separately. The amount of savings that occurs in each of those areas is different and you can't combine them all into one daylighting zone and estimate the savings you need to treat those separately.

[1:08:00]

Primary, side lit, daylight areas are those right next to windows, secondary are further away, and top lit are those under skylights.

In Appendix G it has some rules for dwelling units and guestrooms that are served with plug-in lighting not shown on the plants. It prescribes that in your proposed lighting design you should assume there's .6 watts per square foot. Or as designed, whichever is greater so if you show some fixtures in your proposed design but it's less than .6 watts per square foot you have to assume that it will be .6 watts per square foot the rest will be made up with plug-in lighting.

You can show something different than that. There's an exception. If you've got fixtures with high efficacy and you can demonstrate that they will result in a lighting power less than .6 watts per square foot and you will provide the same illumination as you would have with a six watt per square foot system that gave proper illumination you can get credit.

[1:09:00]

And then, finally, it sets baseline lighting power for dwelling units in Appendix G at 1.07 watts per square foot.

Addendum BI deals with requirements to test the simulation program in accordance with ASHRAE Standard 140.

Appendix G and ECB have long required that simulation programs be tested in accordance with 140 but it ended right there. Only that the simulation program had to be tested. There was no requirements for results or there was no pass/fail or anything like that. There is still not a pass/fail but we have added some new requirements.

Among those, you have to post the results or the software developer has to post the results on a public website along with the results of reference software. And there is reference software in Appendices to Standard 140 so that that way you can compare the simulation software that you're using to the reference software.

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If that simulation program results fall outside of the reference results there's some forms that need to be filled out and posted as well. The modeler needs to be provided a link that they give to the building official with their modeling submittal to those results. But as I said, there still is no pass/fail requirement.

Addendum Z has to do with how you model the efficiency of packaged HVAC equipment. Most simulation programs require you to input the performance of the HVAC system with the impact of the indoor fan unit on it. We call that the COP or the coefficient of performance no fan.

And there was a formula that was used to adjust the rated efficiency of the equipment to a COP no fan efficiency for input in the model. That formula is shown here and in that formula is the term, which represents the capacity of the HVAC equipment.

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The change that was made is that now the Q term tops out at 63 tons. Basically, if you have equipment larger than 63 tons, the Q term stays at 63 tons. That just makes the equation more accurate.

In Appendix G you no longer even need to use that equation, instead there's some tables added to Appendix G that have the COP no fan heating and cooling efficiency to input directly into the model for simplification.

Addendum S applies to renewable energy tradeoffs in both Appendix G and ECB. Previously, you were not allowed to get any credit for renewable energy system if it was not owned, if the renewable energy system was not owned by the building owner. Now there is some other options, if the building owner has signed a lease for a minimum of 15 years to lease that system you can get credit for it. Or if the owner has signed a power purchase agreement to purchase the renewable energy system you can get credit for it as well.

[1:12:00]

This last addendum, Addendum CL applies to ECB only and it makes a bunch of changes to ECB to help better align it with Appendix G. Appendix G is probably been more scrutinized over the last several editions of 90.1 and there were some changes made to it that were not picked up in ECB and this addendum is an attempt to do that.

It just updates the definition of a simulation program to include both the simulation engine and the GUI. It requires a full 8760-hour simulation. So every hour of the year instead of only 1400 hours.

It updates some documentation and submittal requirements to be consistent with Appendix G.

It adds requirements that the weather files include solar radiation, wind speed, and wind direction. It adds some requirements for exceptional calculations, those are calculations that are done outside of the simulation program.

[1:13:00]

There's some sensitivity analysis and documentation that's required. It adds some rules for equipment sizing that's similar to those that we talked about in Appendix G earlier. It allows credit for demand-controlled ventilation that's reduction of the outdoor air ventilation when the building is not fully occupied.

It sets some requirements for baseline system airflow fan sizing. Some requirements for fan temperature and humidity schedules.

As we discussed before, it also specifies that piping losses should not be modeled like they were not in Appendix G.

And then a few other minor changes for clean up and consistency.

Reid Hart: Hello, I'm Reid Hart with Pacific Northwest National Labs here to talk to you today about commissioning changes in Standard 90.1 2019. And I had the privilege of being the chair of the commissioning working group for the last five years.

So today we'll talk about why commissioning in 90.1.

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Why we made some changes and also talk about the actual requirements in the standard.

So why commissioning? Why would we want to be prescribing that in 90.1, which is an energy efficiency standard?

Well, first of all, we assume that all the field assemblies and controls work, but do they? Actual field studies of commissioning have found that commissioning saves in new buildings 7-30 percent or a median of 13 percent of

energy use and that's because things were not working that the commissioning study found and fixed.

A broad scope study of both new and retro commissioning found pretty substantial savings. You can see the graph on the right, the bubbles, the size represents how much savings per building type and offices. An example is 22 percent savings. And you can see that the paybacks of the commissioning effort itself range from one to three years.

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So if we dig a little deeper into this study and look with a focus on new buildings, 90.1 mostly applies to new buildings although it does include renovations and retrofits. There were 82 new buildings in the study across 15 states and when we look at the median savings and costs and new construction the median payback was 4.2 years. And that certainly meets 90.1s cost effectiveness criteria.

Now this is based on a pretty broad study of almost nine million square feet of building area. And in those buildings more than 3,500 deficiencies were found or 43 per buildings. So it does indicate that there is a strong benefit to bringing commissioning to buildings and making sure thing are working as the new building gets launched.

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This chart shows commissioning across different codes efforts, if we start actually over on the right for the last few cycles, 2015 and forward the ICC has had a major revamp of their commissioning description and some pretty clear idea of when you apply and don't apply commissioning.

189.1 put in a new commissioning revision. They did have commissioning requirements but they made them much more clear and included an informative appendix. And in 2019 we tried to follow as much as possible the 189.1 lead and model our structure with requirements as well as informative information to provide the best mix of information. And we'll get into the difference between 2016 and 2019 as we move forward.

Now you might ask why do we need commissioning of energy efficiency requirements?

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After all, commissioning is often done on many building types throughout the industry. Well, we had two interesting questions a few years ago. We were looking at commissioning and building controls and how efficient controls got implemented and we found that talking to 10 different commissioning agencies across the country that 6 out of 10 of them did not include verification of efficiency requirements in their typical commissioning scope.

And also, the same number, 6 out of 10 found that the plans and specifications they were used to looking at did not really include clear language around the efficiency requirements. So there's a real need to bring that up and get some focus in the energy efficiency area with the building construction industry.

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So to conclude why we have a modification of the commissioning for 90.1, there is ASHRAE Standard 202 out there, it defines the commissioning process but it's still up to the owner and the commissioning agent to figure out what they're going to focus their commissioning efforts on. It doesn't tell you what to do. Guideline 0 and 1.1 and other guidelines tell you how to test different controls but again, they don't tell you what to do.

90.1 has very specific items related to energy efficiency both on the control side and the field assembly side that they want to have tested and verified to know that they are going to provide the savings that is predicted.

And in the industry commissioning verification and testing is now accepted. It's not a new thing. It's required as a base in the lead program whereas it used to be in advance, it's required on all federal projects. And it's found to be cost effective based on field studies in the last two decades.

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So what are we going to look at for 90.1 testing and commissioning requirements? Well if we roll back to 2016 and we see what was in that document we did have some functional performance testing for lighting, HVAC, in

optional path and envelop and we had envelope verification requirements.

There was documentation required for those although the documentation was varied depending upon the discipline and it wasn't all brought into one format or place.
In the HVAC area there was commissioning required on buildings over 50,000 square feet and there was some indication of testing requirements for all controls generally but these statements were very general and didn't provide a lot of detail.

As we move forward into 2019 what we've done is pull together a uniform set of documentation requirements so that everything falls under the same umbrella.

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We put that up in chapter four so remember to look to chapter four to see where the actual commissioning and verification testing outline is.

We added some functional testing for power, service water heat, and pressure pumping in some of the other areas and then, we did setup some structure of when that we require testing pretty much in all cases. And then when we add the additional steps of commissioning and we'll get to that in a minute.

So a lot of detail here but if we look on the left, we see had the functional performance testing and envelope HVAC and lighting. And now over on the right, we've added testing for service hot water controls, power system controls, and other controls.

[1:21:00]

As well as indicating in the performance testing the performance paths if you had some new technologies that were not mentioned in the prescriptive part of the standard you would be required to verify that those were operating properly too.

But the most important thing is the top of that list where we put in some cross discipline consistent requirements. There is verification in testing and commissioning provider definitions, which indicate that those folks need to be

qualified and they also need to have at least a quasi-independent situation where they are not directly involved in the construction or the design of the building.

And again, we have clear and standard documentation and we'll get more into detail. The main thrust of it, is moved to Section 4 with each of the individual discipline or area sections having commissioning and functional testing called out in the same locations so that you could clearly see what's going on.

[1:22:00]

So to put it in a nutshell, we started with a verification of functioning performance testing details that were already in the standard. We added some new items that had not previously been covered.

For 2019 we added some more clarity about how you would document those things, what the definition of verification testing providers are, and that there would be provision in the construction documents that those tests could be properly maintained and executed.

And then for buildings where it would be required, we talked about a commissioning process that would focus on the elements in Standard 90.1. And the commissioning process would include the verification and testing that we had already talked about. It's not a separate effort, it is intended to bring everything together into one overall process.

[1:23:00]

So where do we require things? We looked at it, wanted to make the punishment fit the crime, so to speak. We wanted to look at where more complex systems were involved to move through that commissioning process. So basically, buildings under 10,000 square feet, which matches up with 189.1 did not require commissioning at all.

And in addition, buildings that followed the simple HVAC path, which can conclude up to 25,00 square foot buildings those did not have to add on the commissioning requirements. And warehouse as well no matter what the size were also excepted from the commissioning. So that

means that 80 percent of the buildings in the country do not have to follow the commissioning path but all buildings are required to test the things that need testing in the building.

So then, complex buildings under 15,000 square feet, complex as far as HVAC types of systems and all buildings over 50,00 square feet then would follow the commissioning path.

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So what is commissioning? Well it specifically includes all that verification and testing we've been talking about same as required for the smaller buildings. It also included verification that the building meets 90.1 standard. Now the smaller buildings can usually do that just with a comcheck software runout. They don't have the more complicated controls that require a little more expert eye to verify that they're operating.

And there is a requirement for the commissioning plan and reporting to be done following the general process in Standard 202. And there's distinct verification and commissioning discipline sections throughout the standard that can add additional things.

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Although, at this point, they pretty much point to pulling in the verification that is already required.

So the updates were to develop a consistent approach across the technical sections so we have the same type of formatting. It doesn't look completely different from lighting than it does from HVAC. Much easier on the building official.

There is sections on general functional testing and commissioning, definition requirements, that sort of thing up in Section 4. And then, the 90.1 commissioning requirements and format were coordinated with Standards 189.1 and 202 so that there was some parallels. So a building going through 90.1 and 189 would be following similar processes.

The design review was included when communities is required and cost effectiveness for that was justified based on a pretty detailed study done for Title 24.

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And overall, the commissioning also includes a review of 90.1 compliance.

So what documentation is required? We need a commissioning plan. We need to see that information included in the specifications so there's a design review report that also doublechecks that we've to that 90.1 compliance. Much cheaper to make changes at the design stage than it is later.

The verification and functional performance testing reports get included and then a preliminary commissioning report that will include everything that you can find out about up until the occupancy permit time or near that time. And it would also include what additional tests should be done later to lay out what the final commissioning report would look like.

And just a point of clarification, standard 202 is great for laying out the commissioning process, commissioning plan.

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And setting up a full complete process to go through the commissioning approach however, it's still up to the owner what to include in the plan. 90.1 calls for items that really need to be looked at related to 90.1 as far as energy efficiency and wants to also see a design review for compliance with 90.1.

So in conclusion, beyond what 90.1 specifically calls for, there could be additional items that want to be commissioned that the owner wants to include in the scope and that is a good idea, but it's really not the purview of 90.1 so we didn't necessarily require all those things.

And there is an informative appendix, Appendix H that lays out the typical commissioning process and then shows you where are their requirements related to that process in 90.1 so we have a good tieback.

[1:28:00]

And it also shows where there are things that are not necessarily required.

Also in this informative appendix you've got a multipage table that lists all the subsections of the standard that have items that probably should be commissioned so this provides a good starting point for the commissioning agent and the owner to pull together their scope of work as far as what things either need to be verified or tested related to 90.1.

Well, I hope that gives you a clear idea of what changes we brought with commissioning and thanks for your time and attention.

Rosemary Bartlett: So know that we've had some questions come in although I haven't been able to keep a check on all of them so I think what I'll do is I will start with Drake to see if he has any questions that have come in on the overviews of the 90.1 2019.

[1:29:00]

And/or any other comments that he would like to make. Drake, are you on with us?

Drake Erbe: I am.

Rosemary Bartlett: Great, did you have any questions that came in?

Drake Erbe: There weren't any general questions. There was one about the addendum on title purpose and scope relating to site. It's still moving through the process and so, I don't want to get into too much detail on that.

I will say that it is Addendum CB so it is still going through comment stage, it will go back out for public review after, I am sure, another independent substantive change. So look for that.

[1:30:00]

And please, don't hesitate to comment on it. We want to make sure we get this right. And that's the process we go

through is making absolutely sure that you have opportunities, everybody at large, if you will, the entire built environment community has an opportunity to comment on these addenda. Thank you.

Rosemary Bartlett: Great, thanks, Drake. Len, did you have any questions that came in on envelope?

Len Sciarra: Yes. So it looked like there were two questions, one was are there any changes in regards to the envelope assembly? And primarily, the criteria changes were about the windows when we went through those window slides for the SHGC and U factor of windows and then, the material.

The other question was are there standards for industrial buildings? And that's sort of a general question. Yes, industrial buildings would be considered commercial buildings.

[1:31:00]

And as you look through the standard, they're primarily semi-heated buildings. And so, in many cases those are exempt because the mechanical systems are really simple and they usually tend not to have a lot of cooling. So you know, they're basically, boxes. So depending on the type of industrial building it would be exempt or limited requirements.

And then, the one last question and this is a little bit about infiltration modeling. It was asked in relation to Appendix G. CFM is per envelope area so it's not square foot of building its square foot of the above grade building envelope or the building envelope area. Which does include below grade walls. So if you have a basement you get to include that square footage of those walls. So it's rough walls and, yeah, rough walls above grade, and below grade walls. That's how you sort of calculate the area when we talk about CFM per square foot.

So those are the three that I saw.

[1:32:00]

Rosemary Bartlett: Okay, great, Len. Thanks much.

So we'll move on to Jeff, did you have any questions on mechanical?

Jeff: I think I had five. And three of them I think will be quite quick and then if you gong me, you gong me. But one was more a comment than a question, I think on my slideshow I said that we referenced 90.4-2019. I think actually at the time that we finished work on 90.1 2019, 90.4 2016 was the current standard. Although I did check in the back of the standard and there is no year listed. 90.4 doesn't appear at least in the IP version that went out originally as one of our referenced standards. But I believe 2016 is the correct answer for that.

So I also had a question about whether we did an economic analysis for the ERV and nontransient spaces.

[1:33:00]

And yes, we did. I think it was gone over at two different in person meetings. And if you have additional questions about that, we can definitely get you involved with the person who did most of the analysis on that.

I also got a comment from one of the other committee members that today you can get small ERVs that would replace the bathroom exhaust and help to limit the first cost in that. But if you have more questions about, he economics, get a hold of us.

Also, I negligently forgot to include that after 1/1/2023 a lot of air conditioning units that are under 65,000 BTUs in capacity will be rated an SCER 2, EER 2, or HFPF 2 for heat pumps. And referencing the appropriate 2023 AHRI standards. This is probably mostly of interest to manufacturers but it gives them three years to make sure their products are all rated correctly and so forth.

[1:34:00]

So you kind of try to leave the target so manufacturer don't get caught off balance with these type things. For you engineers it just means you'll have to get your specs updated to reference the right standard or somebody might tell you that you're out of date. Although, they still won't be able to see something that doesn't comply.

Let's see, I'm going to do my other short ones first. I had a question about FEI and fan arrays. And basically, the efficiency requires for fan arrays would be essentially, the same as if it was one big fan. The only exception is because the individual motors are smaller, the motor efficiency part of the wire to air will be a little bit different.

So if you have eight fans in a fan array compared to one big fan, you might get a two percent credit or something like that because the motors are smaller motors with lower efficiency requirements.

[1:35:00]

I had a question about ventilation shutoff for VAV and other large systems. I've not had any trouble with that we've just been waiting for 62.1 to allow it. Going all the way to shutoff I find is pretty easy you just close the VAV damper. Or if you're doing something like chilled beam you will need a damper.

And you might want to pressure independent damper, there's some pretty inexpensive units of that type on the market. But basically, if there's no motion sensed and usually it's hooked in with the lighting sensors, you close the VAV box unless the temperature gets out of range.

Usually, I have more trouble with us maintaining the 20 percent minimum that 90.1 requires these days when you are occupied. And I think that's been clarified to say that you can bounce on and off the stop. For example, if your VAV box pressure controller dp sensor for the box doesn’t go low enough to measure 20 percent flow, it only goes low enough to say like 40 percent.

[1:36:00]

You can spend half your time at zero and half your time at 40 percent and it allows you to bump back and forth between those.

There was also a question the CFM per person or per square foot have changed? 90.1 does not really mandate those, those come out of 62 or 170 or your applicable building code.

Okay, so I've got one last one if I've got time and this is about embedded fans. I didn't spend a whole lot of time talking about the exceptions to them. There are several that I didn't mention. We added a definition for embedded fans and it's a fan that's part of a manufactured assembly where the assembly includes functions other than air movement.

The 2013 and 2016 additions of 90.1 pretty much included that but this clarifies the working to make it more understandable.

There's also an exception for fans that are not embedded fans that have a motor and nameplate less than one horsepower.

[1:37:00]

In embedded fans with a nameplate up to five horsepower, embedded fans that are part of equipment listed in section 6.8.1.1, which then refers to a bunch of table 6.8.1-1 through 20. And this is what we sometimes ASHRAE equipment, which is equipment that ASHRAE writes the efficiency standard for as opposed to some equipment, DOE is the main body that writes that standard.

Embedded fans also do include equipment bearing a third-party certified seal for air or energy performance of the equipment package. So we don't actually require that ____ is the only thing you can use, you can do an independently certified thing.

And embedded fans and package equipment the reason they're exempt and I think I mentioned this a little bit is because the total efficiency of the units is already included in the rating and it would kind of be double counting the fan if we did that.

[1:38:00]

There are a few other exceptions that you probably won't run into real often. Fans that operate above 482 degrees Fahrenheit, fans in an explosive environment, well, you will see fans outside the scope of amp 208.

And I think that's all the questions I had.

Rosemary Bartlett: Okay great, Jeff, thanks much. Okay, Michael Myer, I know you have a few to answer on lighting.

Michael Myer: Thank you. I think one of the ones, the first one is can we explain why the lighting power density has gone up for parking garages from 2016 to 2019? It's a great question. Parking garages is not the only value when that went up there are a few others. The primary reason is that the model which develops the values had a wholesale review, every input was reviewed. And during that review process, we discovered that the previous models only considered really two typical reflecting scenarios.

[1:39:00]

So in lighting we talk about reflecting values being the ceiling, the wall, and the floor, 80, 50, 20 is a very common value. The previous model had 70, 50, 20 and 50, 30, 20. Meaning that industrial spaces had a 50 percent reflective ceiling, a 30 percent reflective wall, and a 20 percent reflective floor.

In the process of our review we looked at some other energy efficiency programs and data and they actually said that parking garages they actually used an analysis of 30, 0, 10 meaning the ceiling is 30 percent reflective, 0 percent reflective wall, partially ‘cause many parking garages are open for ventilation and other reasons, and a 10 percent because their concrete.

So because the reflectant value changes or had some guidance, and because the values became darker, the power had to be increase.

[1:40:00]

Because when your materials are darker, more lights absorbed than reflected thus increasing your power density.

I would say of the values, 140 roughly in the table, I would say in the neighborhood of 10 increased primarily because of reflectance values when we reviewed the model input. Another example is a lobby or parts of lobbies for auditoriums and things like that. Again, these tend to be

darker spaces for those reasons. So those are reasons why the changes was made.

Another person asked a question about did the luminal value change? And I think the question is asking is did the light level change? And yes, that also changed. We did a review of every input we have for the model, we compared it to Illuminating Engineering Society guidance. And in some cases, previous values may have been let's say 30-foot candles and the model may have only been doing 24-foot candles. Or vice versa, it may have been doing 35-foot candles.

[1:41:00]

So we recalibrated the model based on guidance from the Illuminating Engineering Society. The Illuminating Engineering Society is the co-organizer of the standard as well as they periodically update their requirements and recommendations so it is good to always go back to it.

So those two inputs can directly change things independent of the efficiency of any of our technologies.

A very astute listener did catch a question there about continuous dimming. No, the daylight dimming is not required, the continuous daylight dimming is not required in all spaces. It is required in spaces where there is what we call a daylight zone and those can be sidelight, daylighted zones, or top lighted daylight zones depending on where the fenestration is.

And so yes, the question is that based on the definitions provided within the standard you then use daylight dimming and it needs to be continuous only when there is a daylight section not in general everywhere.

[1:42:00]

So it's a good question, only in daylight spaces do you need and only in spaces with available daylight do you need to do continuous daylight dimming. And again, that's all defined with great graphics and a fair amount of information in the standard.

I'll answer one more, I'm conscious of time so that's that someone else can do it. Someone did comment about LED lighting and streetlights in Chicago parking garages that the bulbs seem very bright and the distribution doesn't seem as good.

I mean first, it's really hard to be indicative of any one light source. Optics, it comes down to good optical control. First, all light sources can be glary or bright, it's a contrast ratio. So if a fixture is not either designed properly or you just look straight up at it, I promise you, it will appear very bright. Current streetlights that are not LED also appear very bright when you look straight up at them. So that is actually not uncommon.

[1:43:00]

Distribution matters. Just because the light source fixture is LED doesn't mean it's better than another source. I've seen some bad installations where someone put in a poorly designed distribution. Just ‘cause it's LED doesn't mean that the optics are designed right you really need to look at -- the LEDs are really just efficiency of the source and it does allow for some better optical control but if you don't have a product designer who really knows optics that can fail right there.

So ultimately, lighting comes down to what are you trying to light, what are your lighting needs? And your light source and your distribution all matter and there's no one single answer for any source type or any answer. So I can understand the concerns you're seeing but ultimately, work with your site is what I would recommend.

I'll turn over the rest of the time for other questions.

Rosemary Bartlett: All right, thanks, Michael. We'll turn to Michael Rosenberg.

Michael Rosenberg: Can you guys hear me?

[1:44:00]

Okay. I'll follow up on the one that Len answered about infiltration. So Len pointed out that it's the numbers in Appendix G are about the pressure boundary of the

building, the walls, underground floor, underground walls, roof. I just wanted to point out that there are some formulas in Appendix G if your simulation program takes an input of infiltration per area of square foot or per floor area that will help you do those calculations.

There's another one about the building area method and the space by space method. Can you mix those two in your proposed and baseline building? And the answer is no. In general, you have to use the space by space method in both cases unless you know what the spaces are going to be in your proposed building because it's a future buildout like a tenant improvement, in that case use the building area method. And you have to use that in the baseline as well.

What about a carbon metric somebody asked? So the performance paths in Appendix G use energy cost as the metric.

[1:45:00]

There have been some states, New York, Washington State, Washington DC that have been looking at other metrics for the performance path and we recognize that in 90.1. And I think this year we're going to maybe or this cycle we're going to maybe look into an appendix that would give some guidance for those jurisdictions that want to use a metric other than cost. Carbon or source energy are two of the main ones. And how they could do that with the Appendix G approach.

Trying to decide, there's a lot of questions here I gotta page down a little and see if there's another one. Somebody asked about large assembly buildings, the systems, system 12 and 13, I believe it is that apply to large assembly buildings. They are single zone constant volume systems. They're asking if it applies to *[garbled]*

[1:46:00]

And the answer is that Appendix G gives you some explicit recommendations for spaces within the building areas type that may be different because of different loads or schedules. So if you've got some ancillary spaces around the large assembly spaces in a public assembly building, chances are that they will be required to use a different

system. Typically, one of the package single zone systems in addition to the large constant air volume single zone system for the assembly space.

I believe that might be the last one I see here.

Rosemary Bartlett: And Reid, we'll turn it over to you for the last of our questions.

Reid: Okay, I want to answer one first on economics not commissioning since I'm also on the economics working group on 90.1. And there was as question what simple payback do, we use? Well we actually don't use a simple payback although it's part of a functional process. Every three years we look at reasonable commercial discount rates, loan rates.

[1:47:00]

We look at national average energy prices and use EIA energy administration projections for energy and come up with what's called a scaler threshold or target. And so that varies by the equipment life or the measure life that you're looking at.

So for instance, if I've got equipment that has a 20-year measure life then I have to meet a simple payback of about 15 years. And that number is slightly varied for the heating or natural gas side versus the cooling or electrical side and you weight the savings to come up with the exact payback target. So if the payback is under that target, the simple payback then you meet it.

All right, on to commissioning. There was a question whether the study I sited was available?

[1:48:00]

Yes, if you just go in and search the name Mills commissioning and LB&L you will find many studies by Mr. Mills over the years that built on each other and have the commissioning. And if you look at the slides the full title of the study is in there as well.

There was a question about simple buildings and a 50,000 square foot cutoff. So just to clarify, the simple HVAC process is limited at 25,000 square feet. So anything over

25,000 square feet will fall into commissioning. The reason I laid it out that way is the CBECs data about how many buildings are in which category has a break off at 50,000 just so we can see what that was.

And early on we were considering whether to limit design commissioning to above 50,000 but we ended up making the same cut that we did for general commissioning.

[1:49:00]

Commissioning the envelope there was a question about are there changes in those requirements? The actual requirements have stayed the same. You either have to do an onsite verification that everything's going together correctly in the field when the envelope is accessible for inspection. Or you have to do a whole building test as Len talked about based on air pressure in the building.

So there's not really a change in the requirement the only difference is that it is structured. Now I would point out one difference in envelope is they do require a third-party independent inspection whereas for many of the other simple things you could have someone in the firm. So, a design build contractor could have a separate testing person in their firm who's not involved in the installation or the design.

And I think that's it for commissioning.

[1:50:00]

All right, great. Thanks, Reid. So we've made it through everybody and we're just a minute or two over time. So I wanted to thank all of you for attending and I'd like to thank also, all our speakers for their time and attention.

And everybody, thanks again for participating in today's webinar that was brought to you by the US Department of Energy Building Energy Codes Program.

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